Air Quality Monitoring

Girouxville Area Confined Feeding Operations

Fall 2004, Spring 2005 and Spring 2006 Final Report

Introduction

A number of odour complaints had been filed with the Natural Resources Conservation Board (NRCB), the Municipal District of Smoky River No. 130, the Peace Health Region and Alberta Environment regarding confined feeding operations (CFOs) south of Girouxville. Confined feeding operations are operational throughout the year, however most odour complaints were associated with manure spreading taking place in the spring and fall. Odour complaints from CFOs were from the barns, effluent injection in the fields and/or from on-site lagoons that hold animal waste. As a service to NRCB and Peace Country Health, Alberta Environment conducted air quality surveys in the fall of 2004, the spring of 2005 and the spring of 2006. The NRCB who regulate confined livestock operations will use the data for their regulatory purposes and Peace Country Health will determine whether there are health related issues resulting from the data.

The air quality surveys were unannounced and used the department's Mobile Air Monitoring Laboratory (MAML). Pollutants measured by the MAML include ammonia, carbon monoxide, hydrocarbons, oxides of nitrogen, ozone, particulate matter, reduced sulphur compounds and sulphur dioxide. Of these, hydrogen sulphide and ammonia have been associated with odour from livestock waste[2].

The specific objectives of the air quality survey were: (1) Identify and quantify air pollutants in the area of confined feeding operations, (2) evaluate the distribution of pollutants

[2] O'Neill, D.H. and Phillips, V.R. (1992). A review of the control of odour nuisance from livestock buildings: Part 3, Properties of the odorous substances which have been identified in livestock wastes or in the air around them. Journal of agricultural engineering research, 53, pp 23-50.

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away from confined feeding operations and (3) compare concentrations measured to Alberta Ambient Air Quality Objectives (**AAAQOs**).

Monitoring was conducted near a group of hog barns operated by Venture Agri-Corp, Smoky Pork Limited and Blanchette Farms Limited. Mobile and stationary measurements were conducted at various distances from these CFOs. Stationary measurements were conducted for at least an hour to facilitate comparison with one-hour AAAQOs. Data collected during mobile monitoring were used to evaluate the distribution of ammonia and hydrogen sulphide away from a confined feeding operation.

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Overview

Ammonia (NH_3), hydrogen sulphide (H_2S) and polycyclic aromatic hydrocarbons (PAHs) were elevated close to confined feeding operations (CFOs). However, mobile measurements indicate that concentrations of these pollutants rapidly decrease away from these feeding operations.

In the vicinity of Venture Agri-Corp[1] barns (Venture 1), where NH_3 concentrations were among the highest measured for the current study, median one-hour NH_3 concentrations were 0.170 ppm for the *spring 2006 survey* and 0.099 ppm for *fall 2004 survey*. Elevated median one-hour NH_3 of 0.122 ppm were measured downwind of Smokey Pork Limited during the *spring 2005 survey*. These concentrations were notably higher than background levels (< 0.016 ppm), but were lower than the 2 ppm AAAQO and odour thresholds for ammonia.

The highest H_2S concentrations were also measured close to Venture 1 and Smoky Pork Limited. The median one-hour average concentration downwind of Venture 1 was 0.006 ppm for the *fall 2004 survey*. The one-hour average H_2S concentration at the same location during the *spring 2006 survey* was more than double (0.015 ppm). The one-hour average concentration downwind of Smoky Pork Limited measured during the *spring 2005 survey* was similarly high, with concentration of 0.013 ppm. These elevated concentrations measured during the *spring 2005 and 2006 survey* exceeded the AAAQO[2] and H_2S odour thresholds of 0.01 ppm. In contrast, one-hour average H_2S concentrations at the background sites ranged from below detection limit to 0.001 ppm.

Elevated PAHs were measured near (<500 m) the confined feeding operation, Venture 1. The median one-hour average concentration of 8 ng/m^3 was measured during the *fall 2004 survey*; the average concentration the same site during the spring survey was 18 ng/m^3. In comparison, one-hour average background concentrations were below detection limit (<1 ng/m^3). Elevated PAHs during the *spring 2006* and *fall 2004* survey were most probably due to an active incinerator on Venture 1 property.

Hydrogen sulphide most probably contributed to the odour perceived near (<500 m) confined feeding operations. Elevated concentrations that exceed the odour threshold were

[1] Descriptions of the various barns are given in the methods section.
[2] Odour perception is the basis for Alberta's Ambient Air Quality Objective for H_2S (see Appendix B).

measured near (<500 m) CFO fence line and a short distance (<1.5 km) downwind. Odour complaints were filed by residents much further downwind of these facilities. Thus, it is more likely that objectionable odours in the area resulted from a combination of compounds some of which may have been below odour detection individually, or be due to higher concentrations occurring during periods when the MAML was not present.

Monitoring methods and locations

Monitoring was performed using Alberta Environment's mobile laboratory, MAML. The MAML is capable of performing both mobile and stationary measurements. A detailed description of the MAML is given in Appendix B.

During ***stationary monitoring***, air quality data at a site is collected for at least one hour. There were seven such monitoring locations during the *fall 2004 survey*, six during the *spring 2005 survey* and five during the *spring 2006 survey*. Monitoring was conduction in the vicinity of Venture Agri-Corp (Venture 1) (8000 feeders), Venture Agri-Corp 2 (8000 feeders), Smoky Pork Ltd. northern barns (4800 sows), Smoky Pork Ltd. southern barns (13500 wieners) and Blanchette Farms Ltd. (2000 feeders). The three surveys had one common location, **Site 5**, beside Venture 1. A photograph of Venture 1 is presented in Figure A1 in Appendix A. As illustrated in Figure 1, a number of the monitoring sites were located near this facility. It should be noted however, that it is not possible to exactly replicate measurement conditions from one survey to the next. Meteorological conditions and activities in the area will influence measured concentrations. Stationary monitoring locations are described in Table 1; the map in Figure 1 indicates their locations. There was one background site for each survey (**Site 1** for the *fall* 2004 and *spring 2005 survey* and **Site 10** for the *spring 2006 survey*). Furthermore, there were a number of downwind sites at various distances from CFO barns. Stationary measurements can be conducted for an extended period, and thus these measurements are useful in providing information on the overall air quality in the area. One-hour average concentrations determined from such measurements were compared to the one-hour air quality objectives, AAAQOs. For a detailed discussion of the various AAAQOs refer to Appendix B.

Mobile measurements can provide general information on the distribution of pollutants in the surveyed area. *One-minute average* data is collected as the MAML moves slowly en-route. Mobile monitoring data presented in this report were collected during spring 2006. The surveys were conducted along Range Road 231, between Township Road 772 and 770. As illustrated in Figure 1, Venture 1 is located on Range Road 231. The mobile surveys were conducted such that the MAML measured upwind and downwind for CFO barns and injected field.

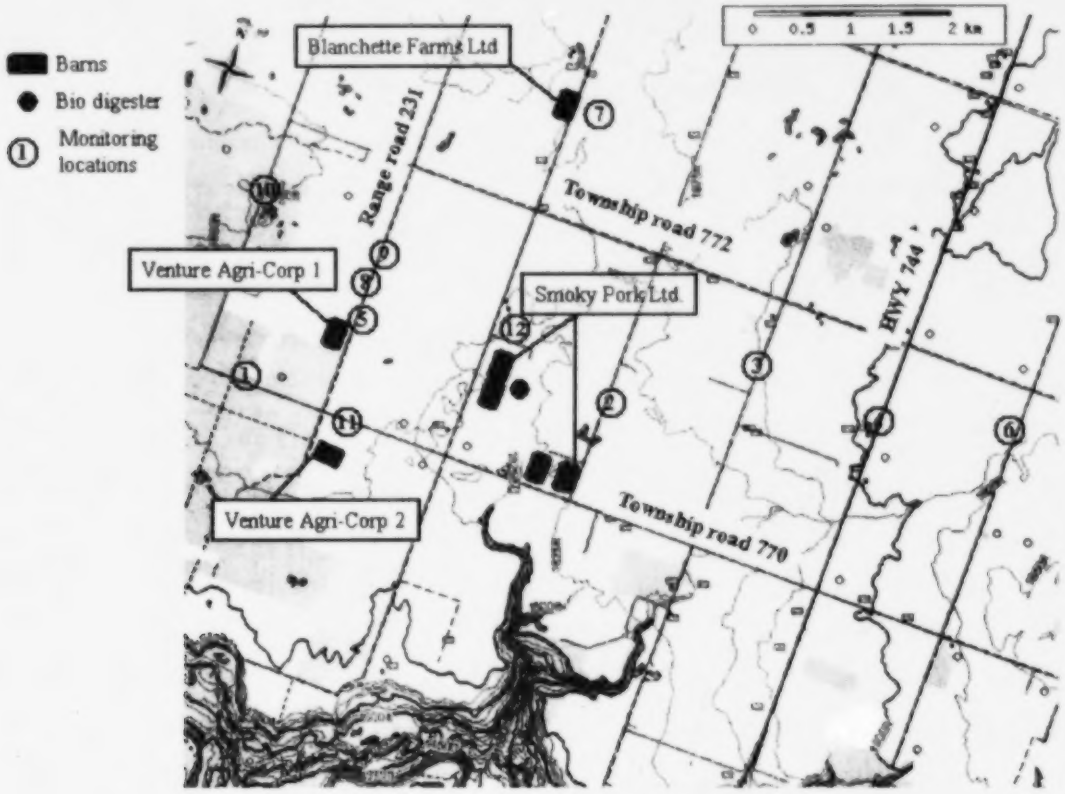

Figure 1: MAML air quality monitoring locations south of Girouxville. The monitoring locations (numbered circles) indicated described in Table 2.

Table 1: Description of MAML monitoring locations (see also map in Figure 1)

SITE	DESCRIPTION	MONITORING DATES
1	Township Road 770 west of Range Road 231 (***background***)	Nov 29 and Nov 30, **2004** June 14, **2005**
2	Range Road 225 between Township Roads 770 and 772 (1.6 km ***downwind*** of Smoky pork Ltd. Barns)	Nov 29, Nov 30 (twice) and Dec 1, **2004** June 14 (twice) and 15, **2005**
3	Range Road 224 between Township Roads 770 and 772	Nov 29, **2004** June 14 (twice), **2005**
4	Highway 774 between Township Roads 770 and 772	Nov 29 and Nov 30, **2004**
5	Range Road 231 ***beside Venture 1***	Nov 30 (twice) and Dec 1, **2004** June 14 (twice) and 15, **2005** April 27th, **2006**
6	Range Road 221 south of Township Road 772	Nov 30 (twice) and Dec 1, **2004**
7	Range Road 230 ***beside*** Blanchette Farms Ltd.	Dec 1 (twice), **2004** June 15, **2005**
8[3]	Range Road 231 and south of Township road 772 (800m ***downwind*** of injected field and ***100m north of Venture 1*** entrance)	April 27th (twice), **2006**
9	Range Road 231 and south of Township road 772 (300m ***downwind*** of injected field and ***600m north of Venture 1*** entrance)	April 27th, **2006**
10	Range Road 232 and south of Township road 772 (***Background***)	April 27th, **2006**
11	Range Road 231 and south of Township road 770 (1.6 km ***downwind*** of Venture Agri-Corp 2)	April 28th, **2006**
12	North side of Smoky Pork ltd. barn and Bio Digester off Range Road 230	June 14, **2005**

[3] Measurement at this location was conducted twice, however the wind direction between the two measurements changed; therefore, when presenting results from this location the location is indicated as 8 or 8a. Meteorological conditions are presented in the appendix (Table A4).

Results and discussion

The MAML is equipped to evaluate the air quality of different environments, and can measure a number of pollutants. The discussion that follows will focus on the pollutants of interest to the current survey, namely ammonia, hydrogen sulphide and polycyclic aromatic hydrocarbons. The reader can refer to Table A1 and A2 in Appendix A for concentrations of all the pollutants measured. For comparison, Table A3 presents median one-hour average concentrations measured at Alberta Environment's permanent monitoring stations (for April 2006) and other mobile surveys.

One-hour average and maximum measured concentrations were used to summarize and discuss the data colleted at the stationary monitoring locations. While the one-hour average concentrations provide insight into the overall concentrations of pollutants, the maximum measured concentrations provide information on short-term elevations. A key for interpreting the graphical presentation of these concentrations is shown in Figure 2. Maximum measured concentrations are determined using one-minute average data. Although short-term elevations cannot be compared to one-hour AAAQOs they can be compared to odour thresholds. A one-hour average concentration is calculated for every hour the MAML measures at a monitoring site. When there are several hours of monitoring at a single location (such as for the *fall 2004 survey* and *spring 2005*), the median one-hour average concentration is used for discussion. The median provides the mid value for a group of concentrations. Further, justification for using the median value can be found in Appendix B.

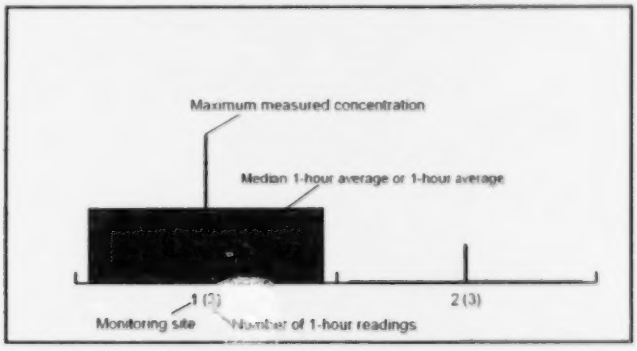

Figure 2: Key for interpreting graphs in the following sections. Median one-hour concentration for Site 2 is at detection limit and thus is not shown on the figure.

Ammonia (NH_3)

Ammonia is a colourless gas with a well-known pungent odour; it is commonly found in household cleaners. NH_3 is produced both by natural and man-made sources. Some natural sources of NH_3 include the decay of plant material and animal waste. A small portion is also released during respiration. In Alberta, the fertilizer industry is the main industrial source of NH_3. The industry produces synthetic NH_3 for either direct application to soil as a fertilizer or as a raw material for use in the production of other high nitrogen fertilizer products. The other major source of NH_3 is commercial feedlots, specifically from their large amounts of decaying animal wastes.

The one-hour average NH_3 concentrations at all the monitoring locations were lower than AAAQO[4] threshold. Furthermore, the maximum concentrations measured at each of the monitoring locations were also below the odour threshold of 2 ppm (Figure 3-5). Concentrations measured downwind of CFOs were elevated; more specifically concentrations measured at **Sites 5, 7 and 12**. The median one-hour average concentration near CFOs ranged from 0.170 ppm measured at **Site 5** during the *spring 2006* survey to 0.099 ppm measured at the same site during *fall 2004 survey*. The maximum concentrations (one-minute) measured close to confined feeding operations ranged from 0.523 to 0.411 ppm. Although all NH_3 concentrations measured downwind of CFOs were lower than the AAAQO and odour thresholds, concentrations were higher than those measured away from the confined feeding operations.

The one-hour average NH_3 concentrations at the background site (**Site 1**) were 0.006 ppm for the *fall 2004 survey* and 0.012 ppm for the *spring 2005 survey*. The one-hour average concentration at **Site 10,** the background site for the *spring survey 2006*, was 0.016 ppm. NH_3 concentrations at the downwind sites were also notably lower than near the CFO barns, this is illustrated in Figures 3 to 5.

The distribution of NH_3 concentrations away from a CFO is illustrated in Figures 6a and 6b. The data were collected while traveling north (Figure 6a) and south (Figure 6b) along Range Road 231 between Township Road 770 and 772. The locations of Venture 1 barn and

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The distribution of NH_3 concentrations away from a CFO is illustrated in Figures 6a and 6b. The data were collected while traveling north (Figure 6a) and south (Figure 6b) along Range Road 231 between Township Road 770 and 772. The locations of Venture 1 barn and

nearby injected field are indicated. The zero distance mark on the x-axis of Figure 6 indicates a location on Range Road 231 adjacent to one edge of the injected field. Field injection is a method of plying manure (in this case hog manure) below the soil surface. Two things are clearly evident from Figures 6a and 6b: (1) NH_3 concentrations are notably high near CFO barns and the injected field and (2) NH_3 concentrations rapidly decrease away from these sources.

NH_3 concentrations measured around CFOs were comparable to the higher range of values observed around the province. The median one-hour average NH_3 concentrations during *other* MAML surveys ranged from 0.084 ppm (Whitecourt, 2005) to below detection limit. For most MAML surveys around Alberta, NH_3 one-hour average concentrations were below 0.004 ppm. NH_3 is monitored at two permanent air quality stations, Fort Saskatchewan and Lethbridge. For April 2006, median one-hour average NH_3 concentrations at these locations were 0.004 ppm and 0.003 ppm, respectively.

It is apparent that concentrations are higher closer to the fence line of CFOs. However, NH_3 concentrations measured during the current surveys were below the odour threshold. The odour associated with CFOs maybe due to a combination of pollutants, which may include the sub odour threshold NH_3, or odours may be due to higher concentrations occurring during the periods when the MAML was not present.

[4] For a discussion on Alberta's Ambient Air Quality Objectives see Appendix B

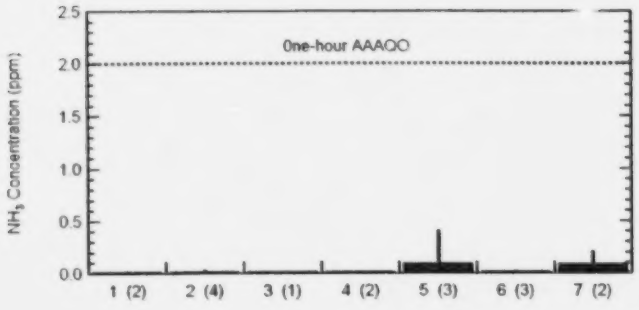

Figure 3: Median one-hour average and maximum measured concentrations for ammonia during the fall, 2004 survey. Concentrations were below detection limit when values are not represented on the figure.

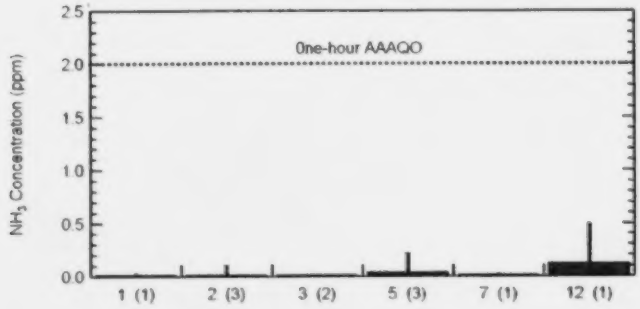

Figure 4: Median one-hour average and maximum measured concentrations for ammonia during the spring, 2005 survey. Concentrations were below detection limit when values are not represented on the figure.

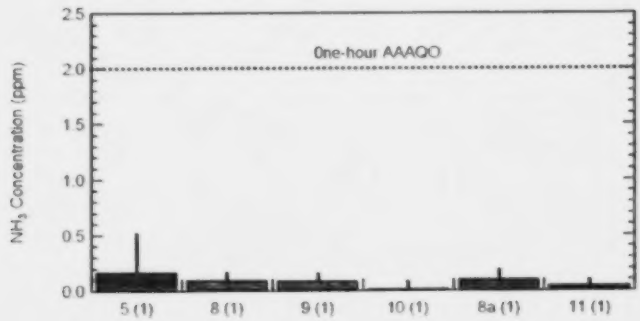

Figure 5: One-hour average and maximum measured concentrations for ammonia during the spring, 2006 survey. Concentrations were below detection limit when values are not represented on the figure.

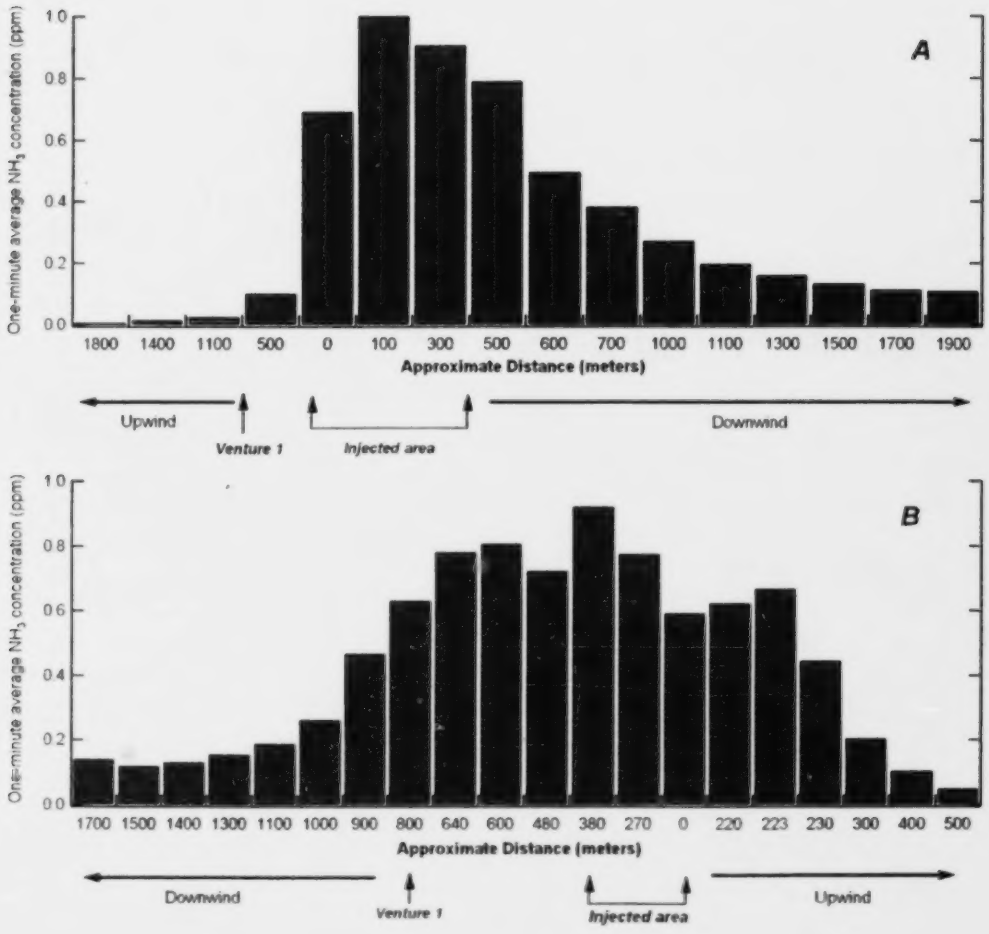

Figure 6: Ammonia concentrations measured while the MAML was traveling slowly on Range Road 231, between Township Road 770 and 772. The samples were taken during the spring 2006 survey. (A) The MAML is driving north. The wind direction at the time of measurement was from the south. (B) The MAML is driving south. The wind direction at the time of measurement was from the northwest. X-axis marks the distance from the start of injected area (0 meters).

Hydrogen Sulphide and Total Reduced Sulphur (H_2S and TRS)

Hydrogen sulphide (H_2S) is a colourless gas with a rotten egg odour. Total reduced sulphur (TRS) includes hydrogen sulphide, mercaptans, dimethyl sulphide, dimethyl disulphide and other sulphur compounds. Sulphur dioxide is not included in the determination of TRS. Industrial sources of H_2S and TRS include fugitive emissions (leakages) from petroleum refineries, tank farms for unrefined petroleum products, natural gas plants, petrochemical plants, oil sands plants, sewage treatment facilities, pulp and paper plants that use the kraft pulping process, and animal feedlots. Natural sources of H_2S include sulphur hot springs, sloughs, swamps and lakes.

Total reduced sulphur (TRS) during the three surveys was largely composed of hydrogen sulphide, with most one-hour average concentration of H_2S and TRS being equivalent. Thus, the discussion that follows will concentrate on H_2S concentrations. Overall, H_2S concentrations in the area were low. However, elevated concentrations were measured close to CFO barns.

Elevated H_2S concentrations were measured downwind of Venture 1 barn during the *fall 2004 and spring 2006 survey* and downwind of Smokey Pork Ltd. during the *spring 2005 survey*. The median one-hour average H_2S concentration at **Site 5** (near Venture 1 barn) during the *fall 2005 survey* was 0.006 ppm. Comparatively higher one-hour average concentration of 0.015 ppm was measured during the *spring 2006 survey*. Median one-hour H_2S concentration downwind of Smokey Pork Ltd. **(Site 12)** during the *spring 2006 survey* was 0.013 ppm. The elevated one-hour concentrations during the *spring 2005* and *2006* survey exceeded the one-hour AAAQO for H_2S and the odour threshold (Figures 7-8). Concentrations were generally lower during the *Fall 2004 survey* (note that the y-axis on Figures 7-8 are not equivalent). However the maximum measured concentration during this survey did exceed the odour threshold.

For the *spring 2006 survey*, **Site 8** and **9** were located such that they were influenced by emissions from a CFO barn and field injection operations. The one-hour average H_2S concentration at **Site 9** (300m downwind of field injection operations and 600m north of Venture

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1) was below detection limit; the maximum concentration measured at this location was 0.001 ppm. As illustrated in Figure 7, concentrations were higher at **Site 8**; this location was closer to the Venture 1 barn entrance (100m) and further from the field injection operations (800m). Thus, elevated H_2S concentrations at the time of monitoring may have had greater contributions from the CFO barns and/or lagoons rather than field injection operations. This is further supported by mobile H_2S measurements.

H_2S distribution away from CFO facilities is shown in Figures 13a and 13b. Elevated H_2S levels were more localized around Venture 1 barns than was observed for NH_3 concentrations. H_2S concentrations were equivalent to background levels 1 km from the CFO barns. For an explanation of the x-axis of Figure 13a and b, refer to the section discussing NH_3 distributions.

A few permanent monitoring stations operated by Alberta Environment monitor H_2S and/or TRS. Where measured, the median one-hour H_2S and TRS concentrations for April 2006 were below detection limit. Median one-hour TRS concentrations measured during other MAML surveys ranged from below detection limit to 0.001 ppm, a value comparable to most one-hour average concentrations measured during this survey. Nevertheless, concentrations measured closer to a CFO barns were higher and at times above the H_2S odour threshold. Therefore, H_2S most probably contributed to the odour associated with CFOs.

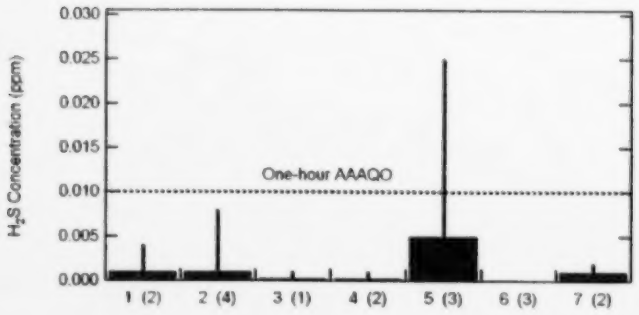

Figure 7: Median one-hour average and maximum measured concentrations for Hydrogen Sulphide during the fall, 2004 survey. Concentrations were below detection limit when values are not represented on the figure.

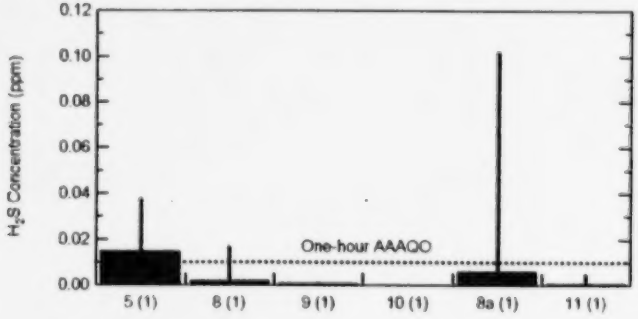

Figure 8: Median one-hour average and maximum measured concentrations for Hydrogen Sulphide during the spring, 2005 survey. Concentrations were below detection limit when values are not represented on the figure.

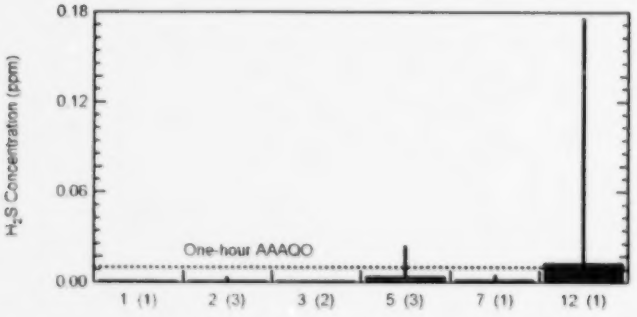

Figure 9: One-hour average and maximum measured concentrations for Hydrogen Sulphide during the spring, 2006 survey. Concentrations were below detection limit when values are not represented on the figure.

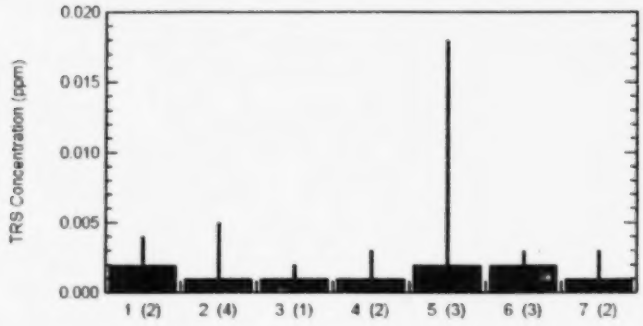

Figure 10: Median one-hour average and maximum concentrations for Total Reduced Sulphur measured during the fall, 2004 survey. There is no AAAQO for TRS. Concentrations were below detection limit when values are not represented on the figure.

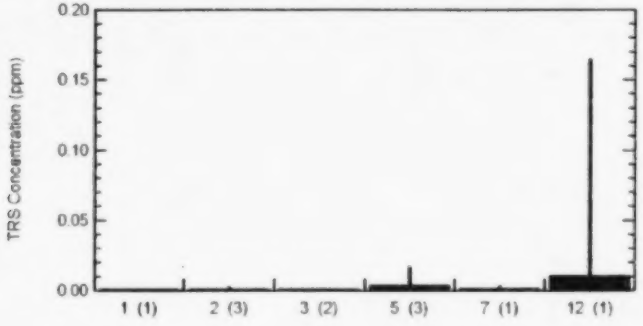

Figure 11: One-hour average and maximum concentrations for Total Reduced Sulphur during the spring, 2005 survey. Concentrations were below detection limit when values are not represented on the figure.

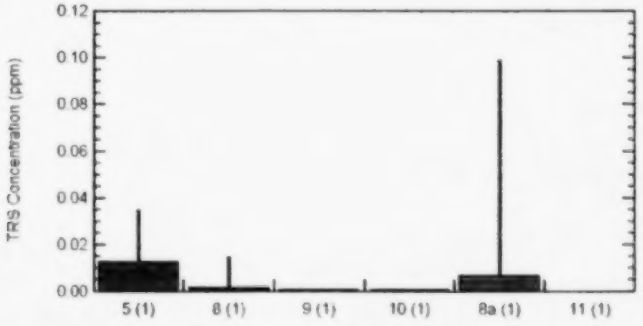

Figure 12: One-hour average and maximum concentrations for Total Reduced Sulphur during the spring, 2006 survey. Concentrations were below detection limit when values are not represented on the figure.

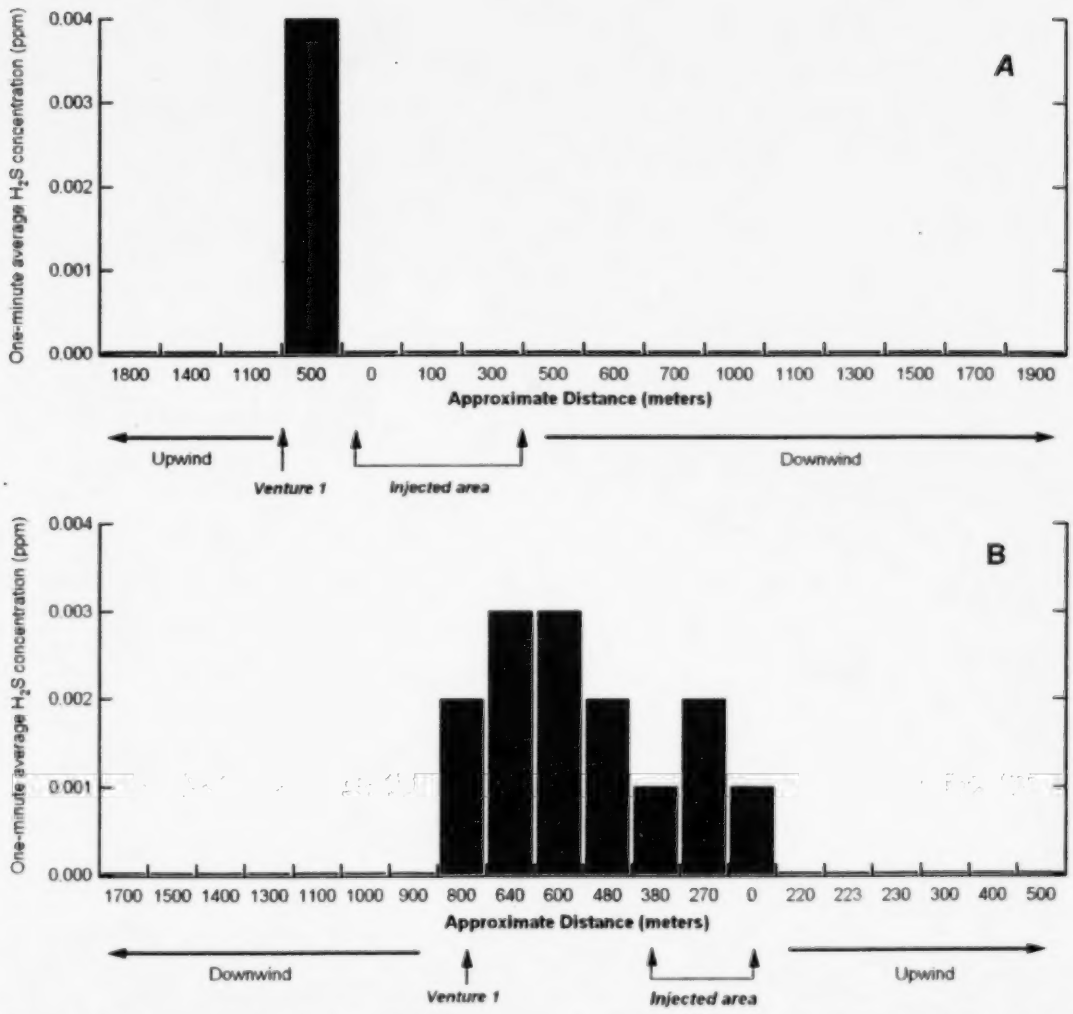

Figure 13: Hydrogen sulphide concentrations measured while the MAML was traveling slowly on Range Road 231, between Township road 770 and 772. The samples were taken during the spring 2006 survey. (A) The MAML is driving north. The wind direction at the time of measurement was form the south. (B) The MAML is driving south. The wind direction at the time of measurement was from the northwest. X-axis marks the distance from the start of injected area (0 meters).

Polycyclic Aromatic Hydrocarbons (PAHs)

Polycyclic aromatic hydrocarbons (PAHs) are a class of hydrocarbons that are usually contained in soot and smoke. There are more than 100 different PAHs with varying levels of toxicity. They are formed during the incomplete combustion of gasoline, diesel, oil, coal, wood, garbage or other organic substances. Tobacco smoke and charbroiled meats are common sources of PAHs. Other outdoor PAH sources include vehicle emissions, wood smoke from fireplaces, smoke from forest fires and industrial facilities. PAHs occur in the atmosphere in the vapour phase or in the condensed phase bound to particles. *The monitoring instrument on the MAML will analyze only particle bound PAHs.*

With the exception of the *spring 2005 survey*, levels of PAHs were highest close to Venture 1 barns. Median one-hour average concentration at **Site 5** (beside Venture 1 barn) during the *fall 2004 survey* was 8 ng/m^3; for the *spring 2006 survey* a one-hour average concentration of 18 ng/m^3 was measured at the same site. In comparison, one-hour background concentrations for both surveys were below detection limit. Elevated PAHs near Venture 1 may have had contributions from an active incinerator onsite. The incinerator was used to burn hog carcasses. High temperature meat cooking is a source of PAHs[5], thus it is reasonable to assume that incineration of hog carcasses is similarly a source of PAHs. During the *spring 2005 survey* there was no indication of an active incinerator on Venture 1 property, this may explain the low PAH levels at this time.

The one-hour average concentrations away from CFO barns were notably lower, however short-term elevated concentrations were measured at a number of sites during the three surveys. A maximum concentration of 26.5 ng/m^3 was measured at **Site 8** (100 m from Venture 1 entrance) and 27.7 ng/m^3 at **Site 11** (1.6 km from Venture 2). Concentrations greater than 60 ng/m^3 were measured at **Site 5** (Venture 1 barn) during the *fall 2004 survey* and at **Site 2** (1.6 km downwind of Smoky Pork Ltd.) during the *spring 2005 survey*. These short-term elevations in PAHs concentrations could have been due to nearby vehicle emissions.

[5] Agency for toxic substances and disease registry. Public health statement for polycyclic aromatic hydrocarbons (PAHs). Retrieved January 5,2007 from http://www.atsdr.cdc.gov/toxprofiles/phs69.html

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The one-hour average concentrations away from CFO barns were notably lower, however short-term elevated concentrations were measured at a number of sites during the three surveys. A maximum concentration of 26.5 ng/m^3 was measured at **Site 8** (100 m from Venture 1 entrance) and 27.7 ng/m^3 at **Site 11** (1.6 km from Venture 2). Concentrations greater than 60 ng/m^3 were measured at **Site 5** (Venture 1 barn) during the *fall 2004 survey* and at **Site 2** (1.6 km downwind of Smoky Pork Ltd.) during the *spring 2005 survey*. These short-term elevations in PAHs concentrations could have been due to nearby vehicle emissions.

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PAHs are not monitored at Alberta Environment's permanent monitoring stations. Median one-hour average PAHs concentrations measured during other MAML surveys ranged from below detection limit to 11 ng/m^3 (Banff). For most surveys, the median one-hour PAHs concentrations were 1 ng/m^3 or lower; these values are comparable to a large number of the measurements away from a CFO fence line.

PAHs measured by the MAML are particle bound. Concentrations of total hydrocarbons (THC) in the gas phase were not significantly elevated near CFOs. During the *fall 2004 survey* one-hour average THC concentrations ranged from 2.6 ppm (**Site 5**) to 2.0 ppm at a downwind location (**Site 4**). One-hour average THC concentrations during the *spring 2006 survey* ranged from 2.3 ppm (**Site 5**) to 2.0 ppm (**Site 8**). During the *spring 2005 survey*, the highest one-hour average THC concentration of 3.0 ppm was measured downwind of Smoky Pork limited barns and lagoon (**Site 12**) one-hour average background concentration for this survey was 1.8 ppm. With the exception of concentration measured at **Site 12**, values were comparable to background hydrocarbon concentrations observed during this and other MAML surveys. Elevated PAHs concentrations and the absence of significant increased THC near CFO barns imply that hydrocarbons associated with CFOs were largely particle bound, most likely arising from active incinerators onsite.

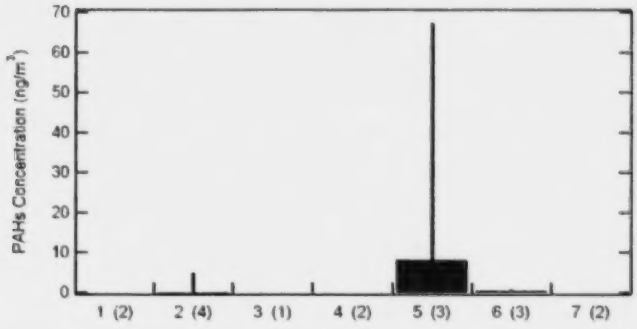

Figure 14: Median one-hour average and maximum measured concentrations for polycyclic aromatic hydrocarbons during the fall, 2004 survey. Concentrations were below detection limit when values are not represented on the figure.

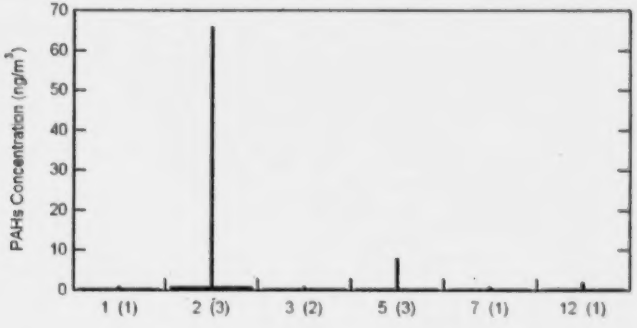

Figure 15: One-hour average and maximum measured concentrations for polycyclic aromatic hydrocarbons during the spring, 2005 survey. Concentrations were below detection limit when values are not represented on the figure.

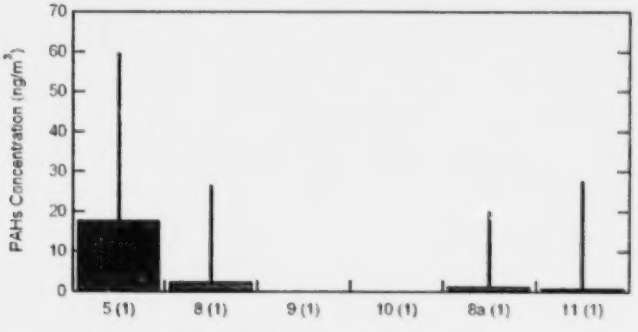

Figure 16: One-hour average and maximum measured concentrations for polycyclic aromatic hydrocarbons during the spring, 2006 survey. Concentrations were below detection limit when values are not represented on the figure.

Appendix A

Table A1: Chronological listing of one-hour average concentrations.

Date	Monitoring Location	Time (MST)	NH_3 (ppm)	O_3 (ppm)	CO (ppm)	CH_4 (ppm)	RHC (ppm)	THC (ppm)	PAH ng/m³	NO (ppm)	NO_2 (ppm)	NO_x (ppm)	TSP (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	H_2S (ppm)	TRS (ppm)	SO_2 (ppm)
29-Nov-04	1	15:05 to 16:10	0.001	0.036	2.0	2.3	bd	2.3	0.2	bd	0.001	0.001	2	1	bd	0.001	bd	0.001
	2	16:28 to 17:31	0.001	0.029	1.6	2.5	bd	2.4	0.3	bd	0.001	0.002	19	10	1	bd	0.001	bd
	3	17:43 to 18:48	bd	0.030	1.5	2.5	nd	2.4	0.2	bd	0.001	0.002	5	3	1	bd	0.001	bd
	4	19:01 to 20:04	0.001	0.028	1.4	2.4	bd	2.3	0.2	bd	0.001	0.002	2	1	bd	bd	bd	bd
30-Nov-04	4	09:46 to 10:49	bd	0.026	bd	2.1	bd	2.0	0.2	0.002	0.001	0.003	29	16	1	bd	0.001	bd
	5	11:03 to 12:06	0.036	0.031	bd	2.3	bd	2.2	0.3	0.005	0.001	0.004	20	11	2	0.001	0.002	0.001
	2	12:26 to 13:26	0.009	0.027	0.1	2.1	bd	2.1	0.4	0.003	0.001	0.004	12	5	bd	0.001	0.003	0.001
	2	13:26 to 14:26	0.003	0.026	0.1	2.0	bd	2.0	0.4	0.005	0.001	0.002	73	32	2	bd	0.001	0.001
	5	14:41 to 15:41	0.099	0.030	0.3	2.4	0.1	2.4	9.8	0.003	0.001	0.004	51	25	3	0.005	0.004	0.001
	1	15:51 to 16:52	0.010	0.031	0.2	2.0	bd	2.1	0.2	0.001	0.001	0.002	3	2	bd	bd	0.003	0.001
	6	17:28 to 18:28	0.002	0.021	0.2	2.1	bd	2.1	0.2	0.001	0.001	0.002	19	12	1	bd	0.002	bd
	6	18:28 to 19:28	bd	0.020	0.2	2.1	bd	2.1	0.4	0.001	0.001	0.001	4	3	1	bd	0.002	bd
1-Dec-04	5	09:04 to 10:06	0.210	0.024	0.3	2.6	0.1	2.6	8.2	0.007	0.003	0.010	111	53	4	0.005	0.002	0.001
	2	10:31 to 11:35	0.024	0.021	0.2	2.3	bd	2.3	0.5	0.002	0.002	0.004	8	3	bd	0.001	0.001	0.001
	7	11:45 to 12:48	0.112	0.027	0.2	2.1	bd	2.1	0.2	0.002	0.001	0.004	36	17	1	0.001	0.001	0.002
	6	13:06 to 14:09	0.016	0.027	0.1	2.1	bd	2.1	0.3	bd	0.001	0.001	7	4	bd	bd	bd	0.002
	7	14:26 to 15:27	0.074	0.026	0.1	2.1	bd	2.2	0.3	bd	0.001	0.001	14	8	1	0.001	0.000	0.002
14-Jun-05	2	08:14 to 09:25	bd	0.018	0.2	1.9	bd	1.9	0.9	0.001	0.001	0.002	8	6	1	0.001	0.001	0.001
	5	09:37 to 10:42	bd	0.020	0.4	1.9	bd	1.9	0.4	0.002	0.001	0.003	14	8	1	0.001	0.001	0.001
	3	11:06 to 12:11	0.005	0.027	0.3	1.8	bd	1.8	0.2	0.001	0.001	0.002	21	15	3	bd	bd	0.002
	5	12:40 to 13:41	0.042	0.029	0.4	1.9	bd	1.9	0.8	0.004	0.001	0.003	46	24	2	0.004	0.004	0.001
	1*	13:46 to 14:50	0.012	0.029	0.3	1.8	bd	1.8	0.2	0.001	0.002	0.001	9	6	1	bd	bd	0.002
	12	15:03 to 16:03	0.122	0.026	0.4	2.9	bd	3.0	0.3	0.008	0.003	0.008	28	15	2	0.013	0.011	0.003
	2	16:14 to 17:14	0.012	0.028	0.5	1.9	bd	1.9	1.4	0.005	0.004	0.003	298	166	15	bd	0.001	0.003
	3	17:24 to 18:28	0.007	0.028	0.5	1.8	bd	1.8	0.2	0.003	0.002	0.003	21	14	2	bd	bd	0.002
15-Jun-05	2	08:08 to 09:20	0.002	0.017	0.6	1.8	bd	1.8	0.5	0.002	0.002	0.003	67	46	6	0.002	0.001	0.002
	7	09:31 to 10:31	0.014	0.025	0.5	1.8	bd	1.8	0.2	0.002	0.001	0.003	14	10	2	0.002	0.002	0.002
	5	10:50 to 11:51	0.136	0.027	0.6	2.0	bd	2.0	0.2	0.004	bd	0.003	48	29	4	0.011	0.009	0.002
27-Apr-06	5	09:08 to 09:49	0.170	0.037	0.3	2.4	bd	2.3	17.7	0.019	0.014	0.031	165	100	10	0.015	0.013	0.001
	8a	11:37 to 12:37	0.097	0.044	0.2	2.1	bd	2.0	2.5	0.005	0.002	0.005	47	18	3	0.002	0.002	0.001
	9	13:48 to 14:48	0.093	0.046	0.2	2.1	bd	2.1	0.8	0.002	0.002	0.003	41	24	3	bd	0.001	0.001
	10*	15:21 to 16:21	0.016	0.047	0.3	2.1	bd	2.1	0.3	0.002	0.001	0.003	11	7	1	bd	0.001	0.001
	8	17:18 to 18:18	0.102	0.049	0.1	2.1	bd	2.1	1.4	bd	0.001	0.002	172	92	8	0.006	0.007	0.002
28-Apr-06	11	07:58 to 09:10	0.047	0.034	0.5	2.1	bd	2.0	0.9	0.005	0.003	0.008	70	37	6	bd	bd	bd

Notes:
*** – Background or upwind site** **bd – below detection limit**
ppm - **parts per million** ng/m³ **= nanograms per cubic meter** µg/m³ **= micrograms per cubic meter**

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Date	Monitoring Location	Time (MST)	NH_3 (ppm)	O_3 (ppm)	CO (ppm)	CH_4 (ppm)	RHC (ppm)	THC (ppm)	PAH ng/m³	NO (ppm)	NO_2 (ppm)	NO_x (ppm)	TSP (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	H_2S (ppm)	TRS (ppm)	SO_2 (ppm)
29-Nov-04	1	15:05 to 16:10	0.001	0.036	2.0	2.3	bd	2.3	0.2	bd	0.001	0.001	2	1	bd	0.001	bd	0.001
	2	16:28 to 17:31	0.001	0.029	1.6	2.5	bd	2.4	0.3	bd	0.001	0.002	19	10	1	bd	0.001	bd
	3	17:43 to 18:48	bd	0.030	1.5	2.5	nd	2.4	0.2	bd	0.001	0.002	5	3	1	bd	0.001	bd
	4	19:01 to 20:04	0.001	0.028	1.4	2.4	bd	2.5	0.2	bd	0.001	0.002	2	1	bd	bd	bd	bd
30-Nov-04	4	09:46 to 10:49	bd	0.026	bd	2.1	bd	2.0	0.2	0.002	0.001	0.003	29	16	1	bd	0.001	bd
	5	11:03 to 12:06	0.036	0.031	bd	2.3	bd	2.2	0.3	0.003	0.001	0.004	20	11	2	0.001	0.002	0.001
	2	12:26 to 13:26	0.009	0.027	0.1	2.1	bd	2.1	0.4	0.003	0.001	0.004	12	5	bd	0.001	0.003	0.001
	2	13:26 to 14:26	0.003	0.026	0.1	2.0	bd	2.0	0.4	0.005	0.001	0.002	73	32	2	bd	0.001	0.001
	5	14:41 to 15:41	0.009	0.030	0.3	2.4	0.1	2.4	9.8	0.003	0.001	0.004	51	25	3	0.005	0.004	0.001
	1	15:51 to 16:52	0.010	0.031	0.2	2.0	bd	2.1	0.2	0.001	0.001	0.002	3	2	bd	bd	0.003	0.001
	6	17:28 to 18:28	0.002	0.021	0.2	2.1	bd	2.1	0.2	0.001	0.001	0.002	19	12	1	bd	0.002	bd
	6	18:28 to 19:28	bd	0.020	0.2	2.1	bd	2.1	0.4	0.001	0.001	0.001	4	3	1	bd	0.002	bd
1-Dec-04	5	09:04 to 10:06	0.210	0.024	0.3	2.6	0.1	2.6	8.2	0.007	0.003	0.010	111	53	4	0.005	0.002	0.001
	2	10:31 to 11:35	0.024	0.021	0.2	2.3	bd	2.3	0.5	0.002	0.002	0.004	8	5	bd	0.001	0.001	0.001
	7	11:45 to 12:48	0.112	0.027	0.2	2.1	bd	2.1	0.2	0.002	0.001	0.004	36	17	1	0.001	0.001	0.002
	6	13:06 to 14:09	0.016	0.027	0.1	2.1	bd	2.1	0.3	bd	0.001	0.001	7	4	bd	bd	bd	0.002
	7	14:26 to 15:27	0.074	0.026	0.1	2.1	bd	2.2	0.3	bd	0.001	0.001	14	8	1	0.001	0.000	0.002
14-Jun-05	2	08:14 to 09:25	bd	0.018	0.2	1.9	bd	1.9	0.9	0.001	0.001	0.002	8	6	1	0.001	0.001	0.001
	5	09:37 to 10:42	bd	0.020	0.4	1.9	bd	1.9	0.4	0.002	0.001	0.003	14	8	1	0.001	0.001	0.001
	3	11:06 to 12:11	0.005	0.027	0.3	1.8	bd	1.8	0.2	0.001	0.001	0.002	21	15	3	bd	bd	0.002
	5	12:40 to 13:41	0.042	0.029	0.4	1.9	bd	1.9	0.8	0.004	0.001	0.003	46	24	2	0.004	0.004	0.001
	1*	13:46 to 14:50	0.012	0.029	0.3	1.8	bd	1.8	0.2	0.001	0.002	0.001	9	6	1	bd	bd	0.002
	12	15:03 to 16:03	0.122	0.026	0.4	2.9	bd	3.0	0.3	0.008	0.003	0.008	28	15	2	0.013	0.011	0.003
	2	16:14 to 17:14	0.012	0.028	0.5	1.9	bd	1.9	1.4	0.005	0.004	0.007	298	166	15	bd	0.001	0.003
	3	17:24 to 18:28	0.007	0.028	0.5	1.8	bd	1.8	0.2	0.003	0.002	0.003	21	14	2	bd	bd	0.002
15-Jun-05	2	08:08 to 09:20	0.002	0.017	0.6	1.8	bd	1.8	0.3	0.002	0.002	0.003	67	46	6	0.002	0.001	0.002
	7	09:31 to 10:31	0.014	0.025	0.5	1.8	bd	1.8	0.2	0.002	0.001	0.003	14	10	2	0.002	0.002	0.002
	5	10:50 to 11:51	0.136	0.027	0.6	2.0	bd	2.0	0.2	0.004	bd	0.003	48	29	4	0.011	0.009	0.002
27-Apr-06	5	09:08 to 09:49	0.170	0.037	0.3	2.4	bd	2.3	17.7	0.019	0.014	0.031	165	100	10	0.015	0.013	0.001
	8a	11:37 to 12:37	0.097	0.044	0.2	2.1	bd	2.0	2.5	0.003	0.002	0.005	27	18	3	0.002	0.002	0.001
	9	13:48 to 14:48	0.093	0.046	0.2	2.1	bd	2.1	0.8	0.002	0.002	0.003	41	24	3	bd	0.001	0.001
	10*	15:21 to 16:21	0.016	0.047	0.3	2.1	bd	2.1	0.3	0.002	0.001	0.003	133	71	7	bd	0.001	0.001
	8	17:18 to 18:18	0.102	0.049	0.1	2.1	bd	2.1	1.4	bd	0.001	0.002	172	92	8	0.006	0.007	0.002
28-Apr-06	11	07:58 to 09:10	0.047	0.034	0.5	2.1	bd	2.0	0.9	0.007	0.003	0.010	1319	793	63	bd	bd	bd

Notes:

*** – Background or upwind site** **bd – below detection limit**

ppm - **parts per million** ng/m³ **= nanograms per cubic meter** µg/m³ **= micrograms per cubic meter**

Table A2: Chronological listing of maximum⁺ concentrations.

Date	Monitoring Location	Time (MST)	NH_3 (ppm)	O_3 (ppm)	CO (ppm)	CH_4 (ppm)	RHC (ppm)	THC (ppm)	PAH ng/m³	NO (ppm)	NO_2 (ppm)	NO_x (ppm)	TSP (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	H_2S (ppm)	TRS (ppm)	SO_2 (ppm)
29-Nov-04	1*	15:05 to 16:10	0.001	0.037	2.1	2.3	bd	2.3	0.7	0.002	0.002	0.003	11	3	1	0.004	0.001	0.002
	2	16:28 to 17:31	0.001	0.036	1.9	2.7	0.1	2.8	2.7	0.002	0.002	0.003	64	32	3	0.002	0.002	0.001
	3	17:43 to 18:48	0.001	0.033	1.6	2.7	bd	2.6	0.6	0.002	0.002	0.003	16	7	1	0.001	0.002	0.001
	4	19:01 to 20:04	0.001	0.032	1.6	2.5	0.0	2.4	0.6	0.004	0.004	0.004	9	6	1	0.001	0.002	0.001
30-Nov-04	4	09:46 to 10:49	0.024	0.033	0.3	2.0	bd	2.1	0.8	0.002	0.002	0.002	12	4	1	bd	0.004	0.002
	5	11:03 to 12:06	0.005	0.044	0.3	2.2	0.2	2.2	1.5	0.024	0.024	0.024	1221	489	32	bd	0.002	0.002
	2	12:26 to 13:26	0.014	0.028	0.1	2.3	0.1	2.2	1.3	0.003	0.003	0.006	269	107	9	0.003	0.005	0.002
	2	13:26 to 14:26	bd	0.028	0.1	2.1	bd	2.0	0.6	0.002	0.002	0.004	127	63	4	bd	0.003	0.001
	5	14:41 to 15:41	0.141	0.032	0.4	2.6	0.6	2.7	38.2	0.002	0.002	0.006	259	68	6	0.025	0.018	0.002
	1	15:51 to 16:52	0.058	0.033	0.1	2.6	0.2	2.4	0.8	0.002	0.002	0.012	56	24	5	0.003	0.005	0.002
	6	17:28 to 18:28	0.000	0.022	0.7	2.1	0.1	2.2	1.1	0.002	0.002	0.002	10	6	1	bd	0.003	0.001
	6	18:28 to 19:28	0.005	0.029	0.3	2.1	bd	2.1	0.8	0.003	0.003	0.003	85	54	4	bd	0.003	0.002
1-Dec-04	5	09:04 to 10:06	0.039	0.035	0.3	3.0	0.2	2.9	5.3	0.005	0.005	0.010	53	31	4	0.008	0.004	0.003
	2	10:31 to 11:35	0.411	0.029	0.5	2.9	0.7	2.9	67.4	0.018	0.018	0.039	259	110	9	0.009	0.006	0.002
	7	11:45 to 12:48	0.029	0.029	0.2	2.2	0.1	2.2	0.8	0.002	0.002	0.002	34	14	1	bd	0.001	0.004
	6	13:06 to 14:09	0.204	0.030	0.2	2.2	0.1	2.3	0.6	0.002	0.002	0.003	41	21	2	0.002	0.002	0.003
	7	14:26 to 15:27	0.216	0.030	0.5	2.2	0.1	2.2	0.5	0.003	0.003	0.006	365	152	10	0.002	0.003	0.003
14-Jun-05	2	08:14 to 09:25	0.001	0.024	0.3	2.0	bd	2.0	5.1	0.003	0.004	0.006	19	13	2	0.004	0.003	0.002
	5	09:37 to 10:42	0.002	0.026	1.7	2.4	bd	2.3	5.6	0.008	0.005	0.011	94	42	3	0.011	0.010	0.003
	3	11:06 to 12:11	0.011	0.029	0.4	1.8	bd	1.9	0.8	0.002	0.002	0.005	140	94	16	0.001	0.001	0.003
	5	12:40 to 13:41	0.118	0.038	2.3	2.2	bd	2.3	8.2	0.031	0.004	0.008	195	97	9	0.015	0.014	0.002
	1	13:46 to 14:50	0.038	0.032	0.3	1.9	bd	1.9	1.4	0.002	0.003	0.002	42	19	2	0.001	0.001	0.003
	12	15:03 to 16:03	0.493	0.029	0.9	8.6	bd	9.3	1.6	0.034	0.008	0.024	273	155	14	0.176	0.165	0.003
	2	16:14 to 17:14	0.017	0.030	1.9	2.0	bd	2.0	66.0	0.037	0.010	0.034	6435	3752	331	0.002	0.002	0.004
	3	17:24 to 18:28	0.012	0.038	1.4	2.3	bd	2.2	0.8	0.013	0.006	0.007	103	70	8	0.001	0.001	0.003
15-Jun-05	2	08:08 to 09:20	0.109	0.020	1.5	2.0	bd	2.0	2.5	0.037	0.003	0.039	2501	1612	184	0.004	0.002	0.004
	7	09:31 to 10:31	0.031	0.027	0.7	1.9	bd	1.9	0.9	0.003	0.002	0.004	63	41	4	0.005	0.004	0.003
	5	10:50 to 11:51	0.217	0.029	0.6	2.3	bd	2.3	0.8	0.006	0.003	0.009	194	136	24	0.024	0.017	0.004
27-Apr-06	5	09:08 to 09:49	0.523	0.044	1.1	3.6	bd	3.5	59.5	0.061	0.192	0.235	1748	948	66	0.038	0.035	0.002
	8a	11:37 to 12:37	0.173	0.047	0.3	2.3	bd	2.3	26.5	0.011	0.011	0.020	450	249	24	0.011	0.015	0.002
	9	13:48 to 14:48	0.159	0.048	0.7	2.1	bd	2.1	5.7	0.005	0.019	0.024	895	483	37	0.001	0.001	0.002
	10*	15:21 to 16:21	0.087	0.052	1.2	2.7	0.4	2.5	2.2	0.007	0.029	0.036	4799	2590	151	bd	0.001	0.002
	8	17:18 to 18:18	0.192	0.053	0.2	2.8	bd	2.7	20.1	0.006	0.009	0.016	974	498	42	0.102	0.099	0.003
28-Apr-06	11	07:58 to 09:10	0.106	0.041	0.9	2.2	0.3	2.1	2.1	0.004	0.021	0.025	1	1	331	0.001	0.001	0.007

Notes:

*** – Background or upwind site** **⁺ - Maximum concentration determined using one-minute average data** **bd – below detection limit**

ppm - **parts per million** ng/m³ **= nanograms per cubic meter** µg/m³ **= micrograms per cubic meter**

Table A2: Chronological listing of maximum* concentrations.

Date	Monitoring Location	Time (MST)	NH_3 (ppm)	O_3 (ppm)	CO (ppm)	CH_4 (ppm)	RHC (ppm)	THC (ppm)	PAH ng/m³	NO (ppm)	NO_2 (ppm)	NO_x (ppm)	TSP (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	H_2S (ppm)	TRS (ppm)	SO_2 (ppm)
29-Nov-04	1*	15:05 to 16:10	0.001	0.037	2.1	2.3	bd	2.3	0.7	0.002	0.002	0.003	11	3	1	0.004	0.001	0.002
	2	16:28 to 17:31	0.001	0.036	1.9	2.7	0.1	2.8	2.7	0.002	0.002	0.003	64	32	3	0.002	0.002	0.001
	3	17:43 to 18:48	0.001	0.033	1.6	2.7	bd	2.6	0.6	0.002	0.002	0.003	16	7	1	0.001	0.002	0.001
	4	19:01 to 20:04	0.001	0.032	1.6	2.5	0.0	2.4	0.6	0.004	0.004	0.004	9	6	1	0.001	0.002	0.001
30-Nov-04	4	09:46 to 10:49	0.024	0.033	0.3	2.0	bd	2.1	0.8	0.002	0.002	0.002	12	4	1	bd	0.004	0.002
	5	11:03 to 12:06	0.005	0.044	0.3	2.2	0.2	2.2	1.5	0.024	0.024	0.024	1221	489	32	bd	0.002	0.002
	2	12:26 to 13:26	0.014	0.028	0.1	2.3	0.1	2.2	1.3	0.003	0.003	0.006	269	107	9	0.003	0.005	0.002
	2	13:26 to 14:26	bd	0.028	0.1	2.1	bd	2.0	0.6	0.002	0.002	0.004	127	63	4	bd	0.003	0.001
	5	14:41 to 15:41	0.141	0.032	0.4	2.6	0.6	2.7	38.2	0.002	0.002	0.006	259	68	6	0.025	0.018	0.002
	1	15:51 to 16:52	0.058	0.033	0.1	2.6	0.2	2.4	0.8	0.002	0.002	0.012	56	24	5	0.003	0.005	0.002
	6	17:28 to 18:28	0.000	0.022	0.7	2.1	0.1	2.2	1.1	0.002	0.002	0.002	10	6	1	bd	0.003	0.001
	6	18:28 to 19:28	0.005	0.029	0.3	2.1	bd	2.1	0.8	0.003	0.003	0.003	85	54	4	bd	0.003	0.002
1-Dec-04	5	09:04 to 10:06	0.039	0.035	0.3	3.0	0.2	2.9	5.3	0.005	0.005	0.010	53	31	4	0.008	0.004	0.003
	2	10:31 to 11:35	0.411	0.029	0.5	2.9	0.7	2.9	67.4	0.018	0.018	0.039	259	110	9	0.009	0.006	0.002
	7	11:45 to 12:48	0.029	0.029	0.2	2.2	0.1	2.2	0.8	0.002	0.002	0.002	34	14	1	bd	0.001	0.004
	6	13:06 to 14:09	0.204	0.030	0.2	2.2	0.1	2.3	0.8	0.002	0.002	0.003	41	21	2	0.002	0.002	0.003
	7	14:26 to 15:27	0.216	0.030	0.5	2.2	0.1	2.2	0.5	0.003	0.003	0.006	365	152	10	0.002	0.003	0.003
14-Jun-05	2	08:14 to 09:25	0.001	0.024	0.3	2.0	bd	2.0	5.1	0.003	0.004	0.006	19	13	2	0.004	0.003	0.002
	5	09:37 to 10:42	0.002	0.026	1.7	2.4	bd	2.3	5.6	0.008	0.005	0.011	94	42	3	0.011	0.010	0.003
	3	11:06 to 12:11	0.011	0.029	0.4	1.8	bd	1.9	0.8	0.002	0.002	0.003	149	94	16	0.001	0.001	0.003
	5	12:40 to 13:41	0.118	0.038	2.3	2.2	bd	2.3	8.2	0.031	0.004	0.008	195	97	9	0.015	0.014	0.002
	1	13:46 to 14:50	0.038	0.032	0.3	1.9	bd	1.9	1.4	0.002	0.003	0.002	42	19	2	0.001	0.001	0.003
	12	15:03 to 16:03	0.493	0.029	0.9	8.6	bd	9.3	1.6	0.034	0.008	0.024	273	155	14	0.176	0.165	0.003
	2	16:14 to 17:14	0.017	0.030	1.9	2.0	bd	2.0	66.0	0.037	0.010	0.034	6435	3752	331	0.002	0.002	0.004
	3	17:24 to 18:28	0.012	0.038	1.4	2.3	bd	2.2	0.8	0.013	0.006	0.007	103	70	8	0.001	0.001	0.003
15-Jun-05	2	08:08 to 09:20	0.109	0.020	1.5	2.0	bd	2.0	2.5	0.037	0.003	0.009	2501	1612	184	0.004	0.002	0.004
	7	09:31 to 10:31	0.031	0.027	0.7	1.9	bd	1.9	0.9	0.003	0.002	0.004	63	41	4	0.005	0.004	0.003
	5	10:50 to 11:51	0.217	0.029	0.6	2.3	bd	2.3	0.8	0.006	0.002	0.005	194	136	24	0.024	0.017	0.004
27-Apr-06	5	09:08 to 09:49	0.523	0.044	1.1	3.6	bd	3.5	59.5	0.061	0.192	0.235	1748	948	66	0.038	0.035	0.002
	8a	11:37 to 12:37	0.173	0.047	0.3	2.3	bd	2.3	26.5	0.011	0.011	0.020	450	249	24	0.017	0.015	0.002
	9	13:48 to 14:48	0.159	0.048	0.7	2.1	bd	2.1	5.7	0.005	0.019	0.024	895	483	37	0.001	0.001	0.002
	10*	15:21 to 16:21	0.087	0.052	1.2	2.2	0.4	2.5	2.2	0.067	0.029	0.029	4799	2260	157	bd	0.001	0.002
	8	17:18 to 18:18	0.192	0.053	0.2	2.8	bd	2.7	20.1	0.006	0.009	0.016	974	498	42	0.102	0.099	0.003
28-Apr-06	11	07:58 to 09:10	0.106	0.041	0.9	2.2	bd	2.1	27.7	0.047	0.051	0.059	19932	11900	881	0.005	0.004	0.007

Notes:

*** – Background or upwind site + – Maximum concentration determined using one-minute average data bd – below detection limit**

ppm – parts per million ng/m³ = nanograms per cubic meter µg/m³ = micrograms per cubic meter

Table A3: Median one-hour air pollutant concentrations in Alberta.

Station or Survey Type	Air Quality Station or Survey Name	Monitoring Period	NH_3 ppm	O_3 ppm	CO ppm	CH_4 ppm	RHC ppm	THC ppm	PAH ng/m³	NO_2 ppm	TSP µg/m³	PM_{10} µg/m³	$PM_{2.5}$ µg/m³	H_2S ppm	TRS ppm	SO_2 ppm
mobile	Girouxville (spring 2006)[1]	April 27-28, 2006	0.095	0.045	0.3	2.1	bd	2.1	1	0.002	149	82	8	0.001	0.002	0.001
	Girouxville (spring 2005)[1]	June14 and 15, 2005	0.012	0.027	0.4	1.9	bd	1.9	bd	0.001	21	15	2	0.001	0.001	0.002
	Girouxville (fall 2004)[1]	29 Nov -1 Dec, 2004	0.009	0.027	0.2	2.1	bd	2.2	bd	0.001	14	8	1	bd	0.001	0.001
	Whitecourt[1]	Sep. 6 - 7, 2005	0.084	0.027	0.2	2.1	bd	2.1	1	0.002	28	16	2	0.001	0.001	0.001
	Lloydminster[1]	Jan. 2002 to Nov. 2004	0.001	0.030	0.2	2.2	0.3	2.5	3	0.008	19	13	2	bd	0.001	0.001
	Lakeland Area[1]	May 2003 to Sep. 2004	0.002	0.031	0.2	2.4	0.2	2.6	bd	0.002	14	9	1	bd	bd	bd
	Banff[1]	Nov. 19 - 23, 2003	0.004	0.018	0.5	2.5	0.2	2.7	11	0.008	7	5	1	0.001	bd	bd
	Fort Saskatchewan/Redwater[1]	May 2001 to Mar. 2002	0.001	0.029	0.3	2.1	0.1	2.1	bd	0.004	39	22	3	bd	bd	0.001
	Cold Lake/Bonnyville/Elk Point[1]	Mar. 2001 to Feb. 2002	0.000	0.031	0.2	1.9	0.1	2.1	1	0.003	16	10	2	bd	0.001	bd
	Whitecourt/Swan Hills/Shiningbank Lake[1]	Mar. 2001 to Jun. 2001	0.001	0.027	0.2	2.0	0.3	2.3	1	0.005	47	29	4	bd	0.001	0.004
	Wabumun[1]	Jul. 2000 to Sep. 2001	0.004	0.027	0.2	1.9	0.1	2.0	1	0.005	34	22	3	bd	bd	0.002
	Edmonton Whitemud Drive[1]	Jun. 2000 to Jul. 2001	bd	0.019	0.4	2.0	0.1	2.2	8	0.014	41	24	3	bd	bd	0.002
Permanent Continuous Monitoring Stations																
urban	Calgary Central[2]	April 2006	n/a	0.025	0.3	n/a	n/a	2.0	n/a	0.020	n/a	22	5	n/a	n/a	n/a
	Calgary East[2]	April 2006	n/a	0.027	0.3	n/a	n/a	2.0	n/a	0.016	n/a	n/a	5	bd	n/a	0.001
	Calgary Northwest[2]	April 2006	n/a	0.035	0.2	n/a	n/a	1.9	n/a	0.010	n/a	n/a	4	n/a	n/a	n/a
	Edmonton Central[2]	April 2006	n/a	0.029	0.3	n/a	n/a	1.9	n/a	0.018	n/a	n/a	6	n/a	n/a	n/a
	Edmonton East[2]	April 2006	n/a	0.037	0.2	n/a	n/a	2.1	n/a	0.010	n/a	n/a	3	bd	n/a	0.001
	Edmonton South[2]	April 2006	n/a	0.038	0.2	n/a	n/a	1.9	n/a	0.009	n/a	20	3	n/a	n/a	n/a
small urban	Fort McMurray[3]	April 2006	n/a	0.035	n/a	n/a	n/a	2.0	n/a	0.002	n/a	n/a	4	n/a	bd	bd
	Fort Saskatchewan[2]	April 2006	0.004	0.029	0.3	n/a	n/a	2.0	n/a	0.010	n/a	n/a	3	bd	n/a	0.001
	Lethbridge	April 2006	0.003	0.037	0.3	n/a	n/a	n/a	n/a	0.004	n/a	n/a	3	bd	n/a	bd
	Red Deer[2]	April 2006	n/a	0.039	0.3	n/a	n/a	1.9	n/a	0.007	n/a	n/a	4	bd	n/a	bd
rural	Beaverlodge[2]	April 2006	n/a	0.044	n/a	n/a	n/a	n/a	n/a	0.002	n/a	n/a	2	n/a	n/a	bd
	Caroline[4]	April 2006	n/a	0.045	n/a	n/a	n/a	2.2	n/a	0.003	n/a	n/a	n/a	n/a	bd	bd
	Carrot Creek[4]	April 2006	n/a	0.045	n/a	n/a	n/a	n/a	n/a	0.004	n/a	n/a	n/a	n/a	n/a	bd
	Fort Chipewyan[3]	April 2006	n/a	n/a	n/a	n/a	n/a	n/a	n/a	bd	n/a	n/a	1	n/a	n/a	bd
	Fort McKay[3]	April 2006	n/a	0.041	n/a	n/a	n/a	2.5	n/a	0.004	n/a	n/a	4	n/a	0.001	bd
	Tomahawk[4]	April 2006	n/a	0.040	n/a	n/a	n/a	n/a	n/a	0.002	n/a	n/a	n/a	n/a	n/a	bd
	Violet Grove[4]	April 2006	n/a	0.047	n/a	n/a	n/a	2.0	n/a	0.003	n/a	n/a	n/a	n/a	n/a	bd
industrial	Buffalo Viewpoint[3]	April 2006	n/a	n/a	n/a	n/a	n/a	n/a	n/a	bd	n/a	n/a	n/a	bd	n/a	bd
	Mannix[3]	April 2006	n/a	n/a	n/a	n/a	n/a	2.1	n/a	n/a	n/a	n/a	n/a	bd	n/a	0.001
	Mildred Lake[3]	April 2006	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	bd	n/a	0.001

NOTES:

1 - Mobile survey conducted using Alberta Environment's MAML.
2 - Station operated by Alberta Environment.
3 - Station operated by the Wood Buffalo Environmental Association.
4 - Station operated by the West Central Airshed Society.
5 - Station operated by the Parkland Airshed Management Association.

ppm - parts per million **ng/m³** = nanograms per cubic meter **µg/m³** = micrograms per cubic meter **n/a** - Parameter not monitored or data not available.
bd - Below lower detection limit of analyzer

Table A3: Median one-hour air pollutant concentrations in Alberta.

Station or Survey Type	Air Quality Station or Survey Name	Monitoring Period	NH_3 ppm	O_3 ppm	CO ppm	CH_4 ppm	RHC ppm	THC ppm	PAH ng/m³	NO_2 ppm	TSP µg/m³	PM_{10} µg/m³	$PM_{2.5}$ µg/m³	H_2S ppm	TRS ppm	SO_2 ppm
mobile	Girouxville (spring 2006)[1]	April 27-28, 2006	0.095	0.045	0.3	2.1	bd	2.1	1	0.002	149	82	8	0.001	0.002	0.001
	Girouxville (spring 2005)[1]	June14 and 15, 2005	0.012	0.027	0.4	1.9	bd	1.9	bd	0.001	21	15	2	0.001	0.001	0.002
	Girouxville (fall 2004)[1]	29 Nov -1 Dec, 2004	0.009	0.027	0.2	2.1	bd	2.2	bd	0.001	14	8	1	bd	0.001	0.001
	Whitecourt[1]	Sep. 6 - 7, 2005	0.084	0.027	0.2	2.1	bd	2.1	1	0.002	28	16	2	0.001	0.001	0.001
	Lloydminster[1]	Jan. 2002 to Nov. 2004	0.001	0.030	0.2	2.2	0.2	2.5	3	0.006	19	13	2	bd	0.001	0.001
	Lakeland Area[1]	May 2003 to Sep. 2004	0.002	0.031	0.2	2.4	0.2	2.6	bd	0.002	14	9	1	bd	bd	bd
	Banff[1]	Nov. 19 - 23, 2003	0.004	0.018	0.5	2.5	0.2	2.7	11	0.008	7	5	1	0.001	bd	bd
	Fort Saskatchewan Redwater[1]	May 2001 to Mar. 2002	0.001	0.029	0.3	2.1	0.1	2.1	bd	0.004	39	22	3	bd	bd	0.001
	Cold Lake/Bonnyville/Elk Point[1]	Mar. 2001 to Feb. 2002	0.000	0.031	0.2	1.9	0.1	2.1	1	0.003	16	10	2	bd	0.001	bd
	Whitecourt/Swan Hills/Shiningbank Lake[1]	Mar. 2001 to Jun. 2001	0.001	0.027	0.2	2.0	0.3	2.3	1	0.005	47	29	4	bd	0.001	0.004
	Wabamun[1]	Jul. 2000 to Sep. 2001	0.004	0.027	0.2	1.9	0.1	2.0	1	0.005	34	22	3	bd	bd	0.002
	Edmonton Whitemud Drive[1]	Jun. 2000 to Jul. 2001	bd	0.019	0.4	2.0	0.1	2.2	6	0.014	41	24	3	bd	bd	0.002
Permanent Continuous Monitoring Stations																
urban	Calgary Central[2]	April 2006	n/a	0.025	0.3	n/a	n/a	2.0	n/a	0.020	n/a	22	5	n/a	n/a	n/a
	Calgary East[2]	April 2006	n/a	0.028	0.3	n/a	n/a	2.0	n/a	0.016	n/a	n/a	5	bd	n/a	0.001
	Calgary Northwest[2]	April 2006	n/a	0.035	0.2	n/a	n/a	1.9	n/a	0.010	n/a	n/a	4	n/a	n/a	n/a
	Edmonton Central[2]	April 2006	n/a	0.029	0.3	n/a	n/a	1.9	n/a	0.018	n/a	n/a	6	n/a	n/a	n/a
	Edmonton East[2]	April 2006	n/a	0.037	0.2	n/a	n/a	2.1	n/a	0.010	n/a	n/a	3	bd	n/a	0.001
	Edmonton South[2]	April 2006	n/a	0.038	0.2	n/a	n/a	1.9	n/a	0.009	n/a	20	3	n/a	n/a	n/a
small urban	Fort McMurray[2]	April 2006	n/a	0.035	n/a	n/a	n/a	2.0	n/a	0.002	n/a	n/a	4	n/a	bd	bd
	Fort Saskatchewan[2]	April 2006	0.004	0.033	0.3	n/a	n/a	2.0	n/a	0.010	n/a	n/a	3	bd	n/a	0.001
	Lethbridge[2]	April 2006	0.003	0.037	0.3	n/a	n/a	n/a	n/a	0.004	n/a	n/a	3	bd	n/a	bd
	Red Deer[2]	April 2006	n/a	0.039	0.3	n/a	n/a	2.0	n/a	0.007	n/a	n/a	4	bd	n/a	bd
rural	Beaverlodge[2]	April 2006	n/a	0.044	n/a	n/a	n/a	n/a	n/a	0.002	n/a	n/a	2	n/a	n/a	bd
	Caroline[5]	April 2006	n/a	0.046	n/a	n/a	n/a	2.3	n/a	0.002	n/a	n/a	n/a	n/a	bd	bd
	Carrot Creek[4]	April 2006	n/a	0.045	n/a	n/a	n/a	n/a	n/a	0.004	n/a	n/a	n/a	n/a	n/a	bd
	Fort Chipewyan[3]	April 2006	n/a	0.037	n/a	n/a	n/a	n/a	n/a	bd	n/a	n/a	1	n/a	n/a	bd
	Fort McKay[3]	April 2006	n/a	0.041	n/a	n/a	n/a	2.5	n/a	0.004	n/a	n/a	4	n/a	0.001	bd
	Tomahawk[4]	April 2006	n/a	0.046	n/a	n/a	n/a	n/a	n/a	0.003	n/a	11	3	n/a	n/a	bd
	Violet Grove[2]	April 2006	n/a	0.047	n/a	n/a	n/a	2.0	n/a	0.003	n/a	n/a	n/a	n/a	n/a	bd
industrial	Buffalo Viewpoint[3]	April 2006	n/a	n/a	n/a	n/a	n/a	2.0	n/a	n/a	n/a	n/a	n/a	bd	n/a	bd
	Mannix[1]	April 2006	n/a	n/a	n/a	n/a	n/a	2.1	n/a	n/a	n/a	n/a	n/a	bd	n/a	0.001
	Mildred Lake[2]	April 2006	n/a	n/a	n/a	n/a	n/a	1.9	n/a	n/a	n/a	n/a	n/a	bd	n/a	0.001

NOTES:

1 - Mobile survey conducted using Alberta Environment's MAML.
2 - Station operated by Alberta Environment.
3 - Station operated by the Wood Buffalo Environmental Association.
4 - Station operated by the West Central Airshed Society.
5 - Station operated by the Parkland Airshed Management Association.

ppm - parts per million **ng/m³** = nanograms per cubic meter **µg/m³** = micrograms per cubic meter **n/a** - Parameter not monitored or data not available.
bd - Below lower detection limit of analyzer

Table A4: Weather conditions base on measurements at monitoring location and operator remarks

Date	Monitoring Location	Time	Temp.	Relative Humidity	Wind Speed	Wind Dir.	Operator's Remarks
			°C	%	km/h		
29-Nov-04	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	2	16:28 to 17:31	2.9	64.7	12.1	W	1 mile downwind of Sow barn
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	4	19:01 to 20:04	1.6	72.8	9.8	W	west wind at approx 10kph
30-Nov-04	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	5	11:03 to 12:06	1.9	65.3	13.1	W	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	2	13:26 to 14:26	2.6	66.0	11.1	WNW	wind has shifted a bit more northerly
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1	15:51 to 16:52	1.7	66.0	10.4	WSW	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	6	18:28 to 19:28	-1.5	86.7	6.8	SSW	
1-Dec-04	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	2	10:31 to 11:35	1.3	80.2	8.4	SW	variable odours - light to strong barn and incinerator odour
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	6	13:06 to 14:09	4.3	68.1	10.2	SW	very faint and fleeting odours
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
14-Jun-05	2	08:14 to 09:25	11.4	94.7	14.3	WSW	Smoky Pork barns approx 1 mile away
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	3	11:06 to 12:11	15.5	70.0	10.6	WNW	2 mile downwind of several barns rain shower during the hour
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1*	13:46 to 14:50	21.6	40.2	12.5	WSW	background site
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	2	16:14 to 17:14	21.7	38.5	9.0	SW	wind is variable direction
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
15-Jun-05	2	08:08 to 09:20	12.8	82.9	12.6	WSW	some barn odour
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	5	10:50 to 11:51	15.9	63.4	22.0	WNW	strong odours throughout the hour
27-Apr-06	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	8	11:37 to 12:37	14.3	26.2	28.5	NNW	tractor doing injection far west of MAML (~800m) and going out of site
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	10	15:21 to 16:21	19.3	16.8	7.1	SSE	upwind site
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
28-Apr-06	11	07:58 to 09:10	17.4	36.4	11.0	SSW	odour (1 km north of Venture Agri-Corp 2)

NOTES:
Temp - Temperature in degrees centigrade **RH** - Relative humidity in percentage **WSP KPH** - Wind speed in Km/hr
WDR DEG - Wind direction in degrees

Table A4: Weather conditions base on measurements at monitoring location and operator remarks

Date	Monitoring Location	Time	Temp.	Relative Humidity	Wind Speed	Wind Dir.	Operator's Remarks
			°C	%	km/h		
29-Nov-04	1	15:05 to 16:10	4.5	54.3	13.3	WSW	background site
	2	16:28 to 17:31	2.9	64.7	12.1	W	1 mile downwind of Sow barn
	3	17:43 to 18:48	1.7	70.6	8.4	WSW	some odours from hog barns in general
	4	19:01 to 20:04	1.6	72.8	9.8	W	west wind at approx 10kph
30-Nov-04	4	09:46 to 10:49	1.0	74.1	8.8	WSW	visit from FOUL member
	5	11:03 to 12:05	1.9	65.3	13.1	W	
	2	12:26 to 13:26	2.2	66.8	12.4	W	downwind from sow barns, incinerator odour
	2	13:26 to 14:26	2.6	66.0	11.1	WNW	wind has shifted a bit more northerly
	5	14:41 to 15:41	2.6	63.4	9.6	W	incinerator is active
	1	15:51 to 16:52	1.7	66.0	10.4	WSW	
	6	17:28 to 18:28	-2.1	84.6	6.5	SW	very light WSW wind
	6	18:28 to 19:28	-1.5	86.7	6.8	SSW	
1-Dec-04	5	09:04 to 10:06	0.0	83.6	8.9	W	truck loading dock & one idling, strong odours incinerator is active
	2	10:31 to 11:35	1.3	80.2	8.4	SW	variable odours - light to strong barn and incinerator odour
	7	11:45 to 12:48	3.2	69.7	11.4	WSW	strong odours from barns incinerator is not active
	6	13:06 to 14:09	4.3	68.1	10.2	SW	very faint and fleeting odours
	7	14:26 to 15:27	3.4	71.8	14.3	WSW	strong odours evident again
14-Jun-05	2	08:14 to 09:25	11.4	94.7	14.3	WSW	Snooky Fork farms approx 1 mile away
	5	09:37 to 10:42	18.5	63.3	6.9	SW	strong odours
	3	11:06 to 12:11	15.5	70.0	10.6	WNW	2 mile downwind of several barns rain shower during the hour
	5	12:40 to 13:41	19.1	50.0	13.0	WSW	stopped alongside Venture1
	1	13:46 to 14:50	21.6	40.2	12.5	WSW	background site
	12	15:03 to 16:03	19.2	47.2	15.2	W	very strong odours
	2	16:14 to 17:14	21.7	38.5	9.0	SW	wind is variable direction
	3	17:24 to 18:28	21.2	41.5	8.8	WNW	move south to find downwind spot roughly same distance away from barns
15-Jun-05	2	08:08 to 09:20	12.8	82.9	12.6	WSW	some barn odour
	7	09:31 to 10:31	14.5	73.3	19.7	NW	odours but different from barn odour, possibly from lagoons
	5	10:50 to 11:51	15.9	63.4	22.0	WNW	strong odours throughout the hour
27-Apr-06	1	09:08 to 09:49	12.9	31.0	23.6	WSW	injection is supposed to be taking place about 400m NW of MAML
	8	11:37 to 12:37	14.3	26.2	28.5	NNW	tractor doing injection far west of MAML (~800m) and going east of site
	9	13:48 to 14:48	16.9	20.9	23.3	WNW	monitor downwind of field that was injected ~300m west of MAML
	10	15:21 to 16:21	19.3	16.8	7.1	SSE	upwind site
	8	17:18 to 18:18	18.3	17.7	15.2	WSW	
28-Apr-06	11	07:58 to 09:10	17.4	36.4	11.0	SSW	about 1.5 km north of Venture Apr-Corp 2-1

NOTES:
Temp - Temperature in degrees centigrade. **RH** – Relative humidity in percentage. **WSP KPH** – Wind speed in Km/hr.
WDR DEG – Wind direction in degrees.

Figure A1: Photograph of Venture 1 barns taken from Range Road 231.

Appendix B

The median concentration

The median concentration is a common way of representing the central value for environmental data. Most environmental data usually consist of a distribution that is skewed to the right; that is most data values are low and only a few are high. For such data sets, the arithmetic mean will be biased by the high concentrations; the resulting value may not be representative of the central value for the data set. For example, a data distribution consisting of five numbers: 1, 2, 2, 3 and 10. The arithmetic mean of these data is 3.6 and the median is 2. In this case, the arithmetic mean is biased high by the extreme value of 10. The median is the middlemost value in the data set; thus more representative of the central value of the data distribution. Fifty percent of the values in the dataset are below the median and fifty percent are above.

Alberta's Ambient Air Quality Objectives

Alberta's Ambient Air Quality Objectives[1] are established under Section 14 of the Environmental Protection and Enhancement Act (EPEA R.S.A. 2000, c.E-12, as amended). EPEA provides for the development of environmental objectives for Alberta.
The Ambient Air Quality Objectives are used for:

- Reporting on the state of the atmospheric environment in Alberta.
- Reporting to Albertans on the quality of the air through Alberta's Air Quality Index (AQI).
- Establishing approval conditions for regulated industrial facilities.
- Evaluating proposals to construct facilities that will have air emissions.
- Guiding special ambient air quality surveys.
- Assessing compliance near major industrial air emission sources.

Some of Alberta's Ambient Air Quality Objectives are based on odour perception. This is the case for ammonia, nitrogen dioxide and hydrogen sulphide. For these chemicals, people are likely to detect an odour at concentrations well below levels that may affect human health. Alberta's Ambient Air Quality Objectives for one-hour average concentration of pollutants monitored by the MAML are listed in Table A5.

Table A5: Alberta's Ambient Air Quality Objective measured by the MAML

Pollutant	One-hour AAAQO (ppm)	Basis for Objective
Ammonia	2	odour perception
Carbon monoxide	13	oxygen carrying capacity of blood
Nitrogen dioxide	0.212	odour perception
Ozone	0.082	reduction of lung function and effects on vegetation
Hydrogen sulphide	0.01	odour perception
Sulphur dioxide	0.172	pulmonary function

ppm – parts per million

[1] *Alberta Ambient Air Quality Objectives*. Alberta Environment. April 2005.

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Sulphur dioxide	0.172	pulmonary function

ppm – parts per million

[1] *Alberta Ambient Air Quality Objectives.* Alberta Environment. April 2005.

The Mobile Air Monitoring Laboratory (MAML)

The MAML is a 27-foot (8.2 m) vehicle that has been specially designed and equipped to measure air quality. It houses a variety of instruments that continuously sample the air at specified time or distance intervals. The MAML is equipped with:

- a dual computer system custom-programmed to accept and record the measurement of air samples from each analyser,
- a GPS (Global Positioning System) that identifies the MAML's location as it moves around Alberta,
- an exhaust purifying system that minimizes emissions from the vehicle and
- two on-board generators that are also equipped with exhaust scrubbers

Table A6 lists the pollutants and meteorological data monitored by the MAML. Also indicated are the lower and upper detection limits for each monitored species.

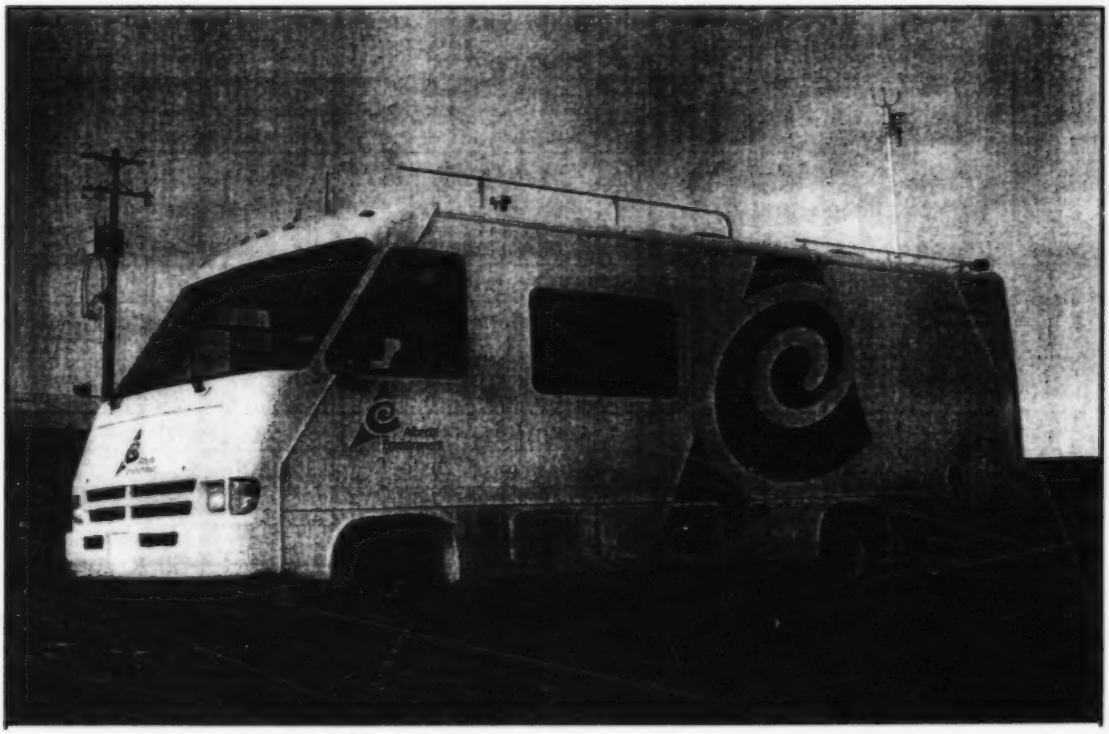

Figure A1: Alberta Environment's Mobile Air Monitoring Laboratory

Table A6: Pollutants and meteorological data monitoring capabilities by the MAML.

Pollutant	Operating Range	
	Lower Detection Limit*	Upper Detection Limit**
Ammonia (NH_3)	0.001 ppm	5 ppm
Ozone (O_3)	0.001 ppm	0.5 ppm
Carbon Monoxide (CO)	0.1 ppm	50 ppm
Hydrocarbons		
Methane (CH_4)	0.1 ppm	20 ppm
Reactive Hydrocarbons (RHC)	0.1 ppm	20 ppm
Total Hydrocarbons (THC)	0.1 ppm	20 ppm
Polycyclic Aromatic Hydrocarbons (PAH)	3 ng/m^3	1000 ng/m^3
Oxides of nitrogen		
Nitrogen dioxide (NO_2)	0.0006 ppm	1 ppm
Nitric Oxide (NO)	0.0006 ppm	1 ppm
Oxides of nitrogen (NO_x)	0.0006 ppm	1 ppm
Particulate Matter		
Total Suspended Particulates (TSP)	1 $\mu g/m^3$	1.0 g/m^3
Particulate Matter <10µm (PM_{10})	1 $\mu g/m^3$	1.0 g/m^3
Particulate Matter <2.5µm ($PM_{2.5}$)	1 $\mu g/m^3$	1.0 g/m^3
Sulphur Compounds		
Hydrogen Sulphide (H_2S)	0.001 ppm	1 ppm
Total Reduced Sulphur (TRS)	0.001 ppm	1 ppm
Sulphur Dioxide (SO_2)	0.001 ppm	2 ppm
Meteorological data		
Wind Speed	0 km/hr	200 km/hr
Wind Direction	0 degrees	360 degrees
Temperature	-40 °C	50 °C
Relative humidity	0%	100%

ppm - parts per million

ng/m^3 = nanograms per cubic meter

$\mu g/m^3$ = micrograms per cubic meter

g/m^3 = grams per cubic meter

* The ***lower detection limit*** indicates the *minimum* amount of pollutant and the lower limit of meteorological data can be measured by the instrument.

** The ***upper detection limit*** indicates the *maximum* amount of pollutant the instrument can detect and the upper limit for meteorological data measured. This limit is set to provide the optimum precision over that range. The upper limit can be raised, however, precision at the lower levels (where most levels are monitored) is then compromised.

Table A6: Pollutants and meteorological data monitoring capabilities by the MAML.

Pollutant	Operating Range	
	Lower Detection Limit*	Upper Detection Limit**
Ammonia (NH_3)	0.001 ppm	5 ppm
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Methane (CH_4)	0.1 ppm	20 ppm
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Total Hydrocarbons (THC)	0.1 ppm	20 ppm
Polycyclic Aromatic Hydrocarbons (PAH)	3 ng/m^3	1000 ng/m^3
Oxides of nitrogen		
Nitrogen dioxide (NO_2)	0.0006 ppm	1 ppm
Nitric Oxide (NO)	0.0006 ppm	1 ppm
Oxides of nitrogen (NO_x)	0.0006 ppm	1 ppm
Particulate Matter		
Total Suspended Particulates (TSP)	1 $\mu g/m^3$	1.0 g/m^3
Particulate Matter <10µm (PM_{10})	1 $\mu g/m^3$	1.0 g/m^3
Particulate Matter <2.5µm ($PM_{2.5}$)	1 $\mu g/m^3$	1.0 g/m^3
Sulphur Compounds		
Hydrogen Sulphide (H_2S)	0.001 ppm	1 ppm
Total Reduced Sulphur (TRS)	0.001 ppm	1 ppm
Sulphur Dioxide (SO_2)	0.001 ppm	2 ppm
Meteorological data		
Wind Speed	0 km/hr	200 km/hr
Wind Direction	0 degrees	360 degrees
Temperature	-40 °C	50 °C
Relative humidity	0%	100%

ppm = parts per million

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* The ***lower detection limit*** indicates the *minimum* amount of pollutant and the lower limit of meteorological data can be measured by the instrument.

** The ***upper detection limit*** indicates the *maximum* amount of pollutant the instrument can detect and the upper limit for meteorological data measured. This limit is set to provide the optimum precision over that range. The upper limit can be raised, however, precision at the lower levels (where most levels are monitored) is then compromised.